## NOTES FROM PACIFIC COAST OBSERVATORIES

### INTERNAL MOTION IN FOUR SPIRAL NEBULAE*

From four nebulae which have been measured, viz.: Messier 101, 33, 51, and 81, the evidence for internal motions thus far derived may be summarized briefly[1]:

For Messier 101 we have two plates taken at the 25-foot focus of the 60-inch reflector, with a 5-year interval; and also three plates taken with the Crossley reflector of the Lick Observatory, which afford two combinations with intervals of 9 and 15 years.

For Messier 33 we have two plates with a 10-year interval taken at the 25-foot focus and two plates with a 5-year interval taken at the 80-foot focus of the 60-inch reflector.

For Messier 51 and Messier 81 we have two plates each with an 11-year interval taken at the 25-foot focus of the 60-inch reflector, while for Messier 81 the older plate was also compared with a plate taken with the same instrument and after an interval of six years.

All pairs of plates show the same type of motion, and, when we keep in mind the different numbers of points measured, the agreement of the motions derived for a given nebula from different pairs of plates is as satisfactory as can be expected.

For the rotational and the radial components the results are collected in Table I. The rotational components would correspond to the following periods: For Messier 101, 85,000 years; for Messier 33, 160,000 years; for Messier 51, 45,000 years; for Messier 81, 58,000 years.

In Messier 101 the linear rotational component, as derived from various points seems to be independent of their positions but for Messier 33, 51 and 81 there appears to be some increase of motion with distance from the center.

All four nebulae show a large radial component outward, which for Messier 101 is 32 per cent of the rotational component; for Messier 33, 48 per cent; for Messier 51, 42 per cent; for Messier 81, 34 per cent.

In all cases, however, the displacements seem to represent a motion along the arms of the spiral more closely than a rotation; for Messier 101 there seems to be a small additional motion inward,

*An * following this, and other titles in the present number indicates that the paper was presented at the Berkeley meeting of the Society, August 4-6, 1921.

[1]At the August meeting four slides were shown, indicating the motions in these nebulae.

TABLE I

| Object | Instrument | Focal Length | Interval in years | $\mu$ rot. | p. e. | $\mu$ rad. | p. e. | No. Points |
|---|---|---|---|---|---|---|---|---|
| M 101 | 60-in. Reflector | 25 feet | 5 | + 0".021* | ± 0".001 | + 0".005* | ± 0".001 | 87 |
| " | Crossley | 18 feet | 9 | + 0 .020 | ± 0 .002 | + 0 .006 | ± 0 .002 | 69 |
| " | Crossley | 18 feet | 15 | + 0 .012 | ± 0 .002 | + 0 .007 | ± 0 .002 | 46 |
| M 33 | 60-in. Reflector | 25 feet | 10 | + 0".020 | ± 0".003 | + 0".006 | ± 0".002 | 30 |
| " | " " | 80 feet | 5 | + 0 .014 | ± 0 .004 | + 0 .012 | ± 0 .004 | 21 |
| M 51 | " " | 25 feet | 11 | + 0".019 | ± "0.001 | + 0".008 | ± 0".001 | 79 |
| M 81 | " " | 25 feet | 6 | + 0".020 | ± 0".004 | + 0".017 | ± 0".003 | 52 |
| " | " " | 25 feet | 11 | + 0 .038 | ± 0 .001 | + 0 .013 | ± 0 .001 | 104 |

*Including the measures by Mr. Nicholson.

while for Messier 33, 51, and 81 this additional motion is outward. But in all these cases the component perpendicular to the arms is small and well within the limits of errors.

The close agreement of the direction of the displacements with the spiral arms suggests that we may have here a realization of the motions described by Jeans in his *Problems of Cosmogony and Stellar Dynamics*, freely quoted in the following lines. If so, we must suppose that before the formation of the spiral arms the nebular masses were rotating and had reached a lenticular shape. The formation of Laplace's ring requires perfect symmetry of the mass about the axis of rotation. The distances of adjacent masses in space are in general so great that their gravitational influence will be extremely small, but even the slightest external gravitational field will be sufficient to preclude the formation of a ring; instead of this the matter will be thrown off at two antipodal points. The first elements of matter thrown off from these two points form in themselves a tide-generating system and the region of ejection will concentrate more and more at two points as the motion proceeds. The result is the extension further and further in the equatorial plane as the evolution of the nebula proceeds. The determination of the shape of the arms seems to be, at present, beyond the reach of mathematical analysis, but the long streams of gas must become longitudinally unstable and will tend to break up into condensations or nuclei.

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## RUBIDIUM IN THE SUN*

Dr. M. N. Saha[1] predicts that the principal lines of rubidium, which are invisible in the solar spectrum, should appear faintly in the spectra of sun-spots.

The search for them is made an easy matter by the recent publication of extensive and accurate tables of wave-lengths in the extreme red, both in the solar spectrum and in the arc, and by the existence at Mount Wilson of a fine set of plates of the spot spectrum extending to λ8200, taken by Mr. Brackett with the 150-foot tower telescope and 75-foot spectrograph, in the first order, with Nicol prism and compound quarter-wave plate.

On examination of these plates rather conspicuous spot-lines

[1] *Phil. Mag.*, **40**, 814, 1920.